Project Proposal

"Face Reconstruction"

1 Abstract

1.1 Objective

This project aims to reconstruct human faces from RGB-D videos with color and depth information. The reconstructed model of a face shall then be aligned with the observed video sequence. As the final output, we expect our reconstructed model to be flexible and simultaneously reflect changes that occur in the input video sequence. This feature enables our model to reconstruct the facial expression and facial pose in real time.

1.2 Technical approach

Firstly, we shall record a few RGB-D videos to populate our basic dataset, which will be used in developing and debugging phase. Besides, it's also necessary to generate a canonical face model (mean shape) for the initial alignment.

Processing the images, we are planning to first track the face position using the facial detection algorithms provided from the Dlib C++ library [2]. In this approach, the corresponding points in the depth point cloud will be marked as facial landmarks for later alignment. After detecting landmarks, we will able to exploit Procrustes analysis [3] to get a coarse affine transformation from the canonical face model to the current model under reconstruction. As a result, we will obtain a first estimate for the face pose for the further optimization.

Subsequently, we plan to find an appropriate parametric model and the constraints, for which we then minimize the energy. The detail of this step is still to be discussed (the previous group use this one [4]), hence currently we can not provide technical information here. For the next phase, we will use the Non-Rigid ICP Algorithm [1] for optimizing the transformation matrix.

2 Requirements

2.1 Libraries

The major libraries we plan to use are:

- **Dlib C++** for face landmark detection
- **Eigen** for matrix calculation
- **Ceres** for solving optimization problem

2.2 Datasets

As we were not able to find any existing, freely available RGB-D facial data sets, we are looking into acquiring an RGB-D Camera for our team to capture our own data for training and testing purposes.

3 Team

All team members:

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4 Milestones

List of our weekly milestones for this project proposal is outlined below:

#	Report due	Milestones planned
1	17.12	First group meeting & work distribution; Starting research into preexisting methods; understanding parametric face models; Basic project code setup
2	24.12	Continuing research; Code: basic data pipeline for offline image stream
	–	Holiday break
3	14.01	Face detection, basic alignment (starting with single image basis)
4	21.01	Refined alignment, basic parameter estimation (face shape)
5	28.01	More detailed parameter estimation (face pose)
6	04.02	Buffer; if other milestones achieved: Time-continuity for model parameters from image stream
7	11.02	Final report & Video due on Thursday 10th; Presentations on Friday

References

[1] Brian Amberg, Sami Romdhani, and Thomas Vetter. Optimal Step Nonrigid ICP Algorithms for Surface Registration. In *2007 IEEE Conference on Computer Vision and Pattern Recognition*, pages 1–8, Minneapolis, MN, USA, June 2007. IEEE.

[2] Davis King. Dlib C++ face landmark detection example.

[3] Mikkel B Stegmann and David Delgado Gomez. A Brief Introduction to Statistical Shape Analysis. page 15.

[4] Justus Thies, Michael Zollhfer, Matthias Niener, Levi Valgaerts, Marc Stamminger, and Christian Theobalt. Real-time expression transfer for facial reenactment. *ACM Transactions on Graphics*, 34(6):1–14, November 2015.